

WHAT IS CLAIMED IS:

1. A multi-beam scanning optical apparatus comprising:

incident optical means for making a plurality of
5 light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

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scanning optical means for forming images of the plurality of light beams deflected by said deflection
10 means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated
15 upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect
20 to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface
25 by the plurality of light beams whose images are formed on the scanning surface through said scanning optical element made of the resin changes in the main scanning

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direction in an effective scanning region, and

wherein said apparatus comprises at least one setting means for setting a sub-scanning interval error between the scanning lines due to a polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 1/5 of a desired scanning line interval.

2. An apparatus according to claim 1, wherein the direction of the principal axes of the birefringence at the end portions of said scanning optical element made of the resin form an asymmetrical distribution due to the stress distribution generated upon cooling in the molding process of said scanning optical element made of the resin.

3. An apparatus according to claim 1, wherein said apparatus has a plurality of scanning optical elements made of the resin.

4. An apparatus according to claim 1, wherein said scanning optical means includes refractive optical elements all of which are scanning optical elements made of a resin.

5. An apparatus according to claim 1, wherein said scanning optical means includes a scanning optical

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element made of glass.

5 6. An apparatus according to claim 1, wherein
said scanning optical means includes a reflecting
optical element having a power.

10 7. An apparatus according to claim 1, wherein
said setting means sets the polarization angle
difference between the light beams emitted from the
plurality of light emitting portions to be not more
than 20°.

15 8. An apparatus according to claim 1, wherein
said setting means comprises correction means for
correcting the polarization angle difference between
the plurality of light beams incident on said scanning
optical element made of the resin.

20 9. An apparatus according to claim 8, wherein
said correction means comprises polarized light
limiting means inserted into an optical path between
the light source means and said scanning optical
element made of the resin.

25 10. An apparatus according to claim 9, wherein
said polarized light limiting means is tilted with
respect to the optical axis of said incident optical

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means.

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11. An apparatus according to claim 1, wherein the plurality of light emitting portions are independently arranged.

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12. An apparatus according to claim 11, wherein said setting means comprises adjustment means capable of independently adjusting polarization angles of the light beams emitted from the plurality of light emitting portions.

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13. An apparatus according to claim 1, wherein the light source means comprises a monolithic multi-beam light source.

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14. An apparatus according to claim 13, wherein said apparatus has a plurality of monolithic multi-beam light sources.

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15. An apparatus according to claim 14, wherein said setting means comprises adjustment means capable of independently adjusting polarization angles of the light beams emitted from the plurality of monolithic multi-beam light sources.

16. An apparatus according to claim 1, wherein

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said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction and/or rotary-decentered about the main scanning direction.

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17. An apparatus according to claim 1, wherein letting h be a sub-scanning width of said scanning optical element made of the resin and d be an optical-axis-direction width, $h/d \leq 1.8$ is satisfied.

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18. An apparatus according to claim 1, wherein letting h be a sub-scanning width of said scanning optical element made of the resin and t be a sub-scanning width of the light beam passing through
15 said scanning optical element made of the resin, $h/t \leq 15$ is satisfied.

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A' > 19. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of any
20 one of claims 1 to 18;
a photosensitive member disposed in the scanning surface;
a developer for developing, as a toner image, an electrostatic latent image formed on said
25 photosensitive member by light beams scanned by said multi-beam scanning optical apparatus;
a transfer device for transferring the developed

toner image onto a transfer member; and

a fixing device for fixing the transferred toner image on the transfer member.

5 20. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of any
one of claims 1 to 18; and
a printer controller for converting code data
received from an external device into an image signal
10 and inputting the image signal to said scanning optical
apparatus.

21. A multi-beam scanning optical apparatus
comprising:
15 incident optical means for making a plurality of
light beams emitted from light source means having a
plurality of light emitting portions incident on
deflection means; and

scanning optical means for forming images of the
20 plurality of light beams deflected by said deflection
means on a surface to be scanned,

wherein said scanning optical means has at least
one scanning optical element made of a resin, and said
scanning optical element made of the resin has
25 birefringence due to a stress distribution generated
upon cooling in a molding process thereof such that the
directions of principal axes of birefringence at one

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end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface by the plurality of light beams whose images are formed on the scanning surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting a sub-scanning interval error between the scanning lines due to a polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 1/5 of a desired scanning line interval,

said setting means setting the polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 20°.

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22. An image forming apparatus comprising:

said multi-beam scanning optical apparatus of claim 21;

a photosensitive member disposed in the scanning

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surface;

a developer for developing, as a toner image, an electrostatic latent image formed on said photosensitive member by light beams scanned by said multi-beam scanning optical apparatus;

a transfer device for transferring the developed toner image onto a transfer member; and

a fixing device for fixing the transferred toner image on the transfer member.

23. An image forming apparatus comprising:

said multi-beam scanning optical apparatus of claim 21; and

a printer controller for converting code data received from an external device into an image signal and inputting the image signal to said scanning optical apparatus.

24. A multi-beam scanning optical apparatus comprising:

incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface by the plurality of light beams whose images are formed on the scanning surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting a sub-scanning interval error between the scanning lines due to a polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than $1/5$ of a desired scanning line interval,

said setting means comprising correction means for correcting the polarization angle difference between the plurality of light beams incident on said scanning

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optical element made of the resin.

25. An apparatus according to claim 24, wherein
said setting means comprises adjustment means capable
5 of independently adjusting polarization angles of the
light beams emitted from the plurality of light
emitting portions.

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26. An apparatus according to claim 24, wherein
10 said setting means comprises polarized light limiting
means inserted into an optical path between the light
source means and said scanning optical element made of
the resin.

15 27. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of
claim 24;

a photosensitive member disposed in the scanning
target surface;

20 a developer for developing, as a toner image, an
electrostatic latent image formed on said
photosensitive member by light beams scanned by said
multi-beam scanning optical apparatus;

25 a transfer device for transferring the developed
toner image onto a transfer member; and

a fixing device for fixing the transferred toner
image on the transfer member.

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28. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of
claim 24; and
a printer controller for converting code data
5 received from an external device into an image signal
and inputting the image signal to said scanning optical
apparatus.

29. A multi-beam scanning optical apparatus
10 comprising:
incident optical means for making a plurality of
light beams emitted from light source means having a
plurality of light emitting portions incident on
deflection means; and

15 scanning optical means for forming images of the
plurality of light beams deflected by said deflection
means on a surface to be scanned,

wherein said scanning optical means has at least
one scanning optical element made of a resin, and said
20 scanning optical element made of the resin has
birefringence due to a stress distribution generated
upon cooling in a molding process thereof such that the
directions of principal axes of birefringence at one
end portion of said scanning optical element made of
25 the resin are different from those at the other end
portion, opposite to said one end portion with respect
to an optical axis thereof in a main scanning

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direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface by the plurality of light beams whose images are formed on the scanning surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting a sub-scanning interval error between the scanning lines due to a polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 1/5 of a desired scanning line interval,

said setting means comprising a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction and/or rotary-decentered about the main scanning direction.

20 A⁴> 30. An image forming apparatus comprising:

said multi-beam scanning optical apparatus of claim 29;

a photosensitive member disposed in the scanning surface;

25 a developer for developing, as a toner image, an electrostatic latent image formed on said photosensitive member by light beams scanned by said

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multi-beam scanning optical apparatus;
a transfer device for transferring the developed
toner image onto a transfer member; and
a fixing device for fixing the transferred toner
5 image on the transfer member.

31. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of
claim 29; and
10 a printer controller for converting code data
received from an external device into an image signal
and inputting the image signal to said scanning optical
apparatus.

32. A multi-beam scanning optical apparatus
comprising:
incident optical means for making a plurality of
light beams emitted from light source means having a
plurality of light emitting portions incident on
20 deflection means; and

scanning optical means for forming images of the
plurality of light beams deflected by said deflection
means on a surface to be scanned,

wherein said scanning optical means has at least
25 one scanning optical element made of a resin, and said
scanning optical element made of the resin has
birefringence due to a stress distribution generated

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upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface by the plurality of light beams whose images are formed on the scanning surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting an actual sub-scanning interval error between the scanning lines on the scanning surface to be smaller than the sub-scanning interval error between the scanning lines on the scanning surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction and/or rotary-decentered about the main scanning direction.

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33. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of
claim 32;
a photosensitive member disposed in the scanning
5 surface;
a developer for developing, as a toner image, an
electrostatic latent image formed on said
photosensitive member by light beams scanned by said
multi-beam scanning optical apparatus;
10 a transfer device for transferring the developed
toner image onto a transfer member; and
a fixing device for fixing the transferred toner
image on the transfer member.
- 15 34. An image forming apparatus comprising:
said multi-beam scanning optical apparatus of
claim 32; and
a printer controller for converting code data
received from an external device into an image signal
20 and inputting the image signal to said scanning optical
apparatus.
35. A multi-beam scanning optical apparatus
comprising:
25 incident optical means for making a plurality of
light beams emitted from light source means having a
plurality of light emitting portions incident on

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deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

5 wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the
10 directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning
15 direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanning surface by the plurality of light beams whose images are formed
20 on the scanning surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting an actual sub-scanning interval error
25 between the scanning lines on the scanning target surface to be smaller than the sub-scanning interval error between the scanning lines on the scanning

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surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising polarized light limiting means inserted into an optical path between the light source means and said scanning optical element made of the resin.

45 > 36. An image forming apparatus comprising:

10 said multi-beam scanning optical apparatus of claim 35;

a photosensitive member disposed in the scanning surface;

15 a developer for developing, as a toner image, an electrostatic latent image formed on said photosensitive member by light beams scanned by said multi-beam scanning optical apparatus;

a transfer device for transferring the developed toner image onto a transfer member; and

20 a fixing device for fixing the transferred toner image on the transfer member.

37. An image forming apparatus comprising:

25 said multi-beam scanning optical apparatus of claim 35; and

a printer controller for converting code data received from an external device into an image signal

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and inputting the image signal to said scanning optical
apparatus.

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